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BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Application Number: 10/629,877
Filing Date: July 29, 2003
Appellant(s): JIBBE, MAHMOUD K.

David S. Atkinson
For Appellant

EXAMINER'S ANSWER

This is in response to the appeal brief filed 6/14/07 appealing from the Office action mailed 9/6/06.

(1) Real Party in interest

A statement identifying by name the real party interest is contained in the brief.

(2) Related Appeals and Interferences

The examiner is not aware of any related appeals, interferences, or judicial proceedings which will directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal.

(3) Status of Claims

The statement of the status of claims contained in the brief is correct.

(4) Status of Amendments After Final

No amendment after final has been filed.

(5) Summary of Claimed Subject Matter

The summary of claimed subject matter contained in the brief is correct.

(6) Grounds of Rejection to be Reviewed on Appeal

The appellant's statement of the grounds of rejection to be reviewed on appeal is correct.

(7) Claims Appendix

The copy of the appealed claims contained in the Appendix to the brief is correct.

(8) Evidence Relied Upon

US 6351831	Sawdy et al	2-2002
US 6874100	Rauscher	3-2005
US 2004/0068591	Workman et al	4-2004
US 2002/0019897	Cruyningen et al	2-2002
US 5944838	Jantz	8-1999
US 6937608	Deng	8-2005
US 2003/001400	Ito et al	1-2003

Brocade's QuickLoop data sheet 6-2002

(9) Grounds of Rejection

The following ground(s) of rejection are applicable to the appealed claims:

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 1-2,4,8-9 rejected under 35 U.S.C. 103(a) as being unpatentable over Sawdy et al (US 6351831) in view of Rauscher (US 6874100) and further in view of Cruyningen (US Pub 2002/0019897).

As in claim 1, Sawdy describes a storage array network, comprising: a first and second storage array controller module (Fig 2: #210,212), wherein each storage array controller module has a first and second array controller unit; and an array of storage devices (Fig 5: #70), wherein the first storage array controller module is a primary storage array controller that normally

performs storage array controller functions and the second storage array controller module is a redundant back up (Sawdy's column 1 lines 1-20);

The claim further recites wherein the first array controller module provides an availability signal to the second storage array controller module, wherein if the second array controller module does not receive a signal from the first storage array controller module within a given period of time, the second storage array controller module asserts control over the array of storage devices. Sawdy does not describe the claim's aspect of "heartbeat" signal between the storage array controller modules. However, Rauscher describes an active RAID system with multiple controllers in which the controllers are communicating with each other via "heartbeat" connections (Rauscher's column 2 lines 56-68). It would have been obvious to one of ordinary skill in the art at the time of invention to include the heartbeat connect as suggested by Rauscher in Sawdy' system to inform each controller the status of the other controller, and thereby allowing the other controller quickly take over the failed controller automatically (Rauscher's column 2 lines 5-15, lines 57-68). Sawdy and Rauscher do not expressly disclose the claim's detail of first and second array controller units. However Cruyningen describes a storage array configuration (Cruyningen's Fig 7) in which multiple disks units (Cruyningen's Fig 7 disks in unit 20a and disks in unit 20b) are grouped and controlled by the controller Fig 7: #10a. It would have been obvious to one of ordinary skill in the art at the time of invention to include grouping disks into units as suggested by Cruyningen in Sawdy' system such that devices can be easily managed; for example an additional unit of storage being added into an existing storage channel partition (Cruyningen's page 3 paragraph 42).

As in claims 2,4, the claims recites a storage array switch electrically connected between the first and second storage array controller modules and the array of storage devices (claim 2); first and second interface switches and first and second host devices electrically connectable to the first and second storage array controller modules through the first and second interface switches (claim 4); Sawdy's Fig 4 describes the multiples controllers are connecting to multiple disk arrays with multiple "switches" hubs (Fig 4: #400, #402).

As in claim 8-9, Sawdy describes wherein redundancy and drive control is accomplished through multiple storage array controller modules (claim 8); wherein, if one of the storage array controller modules fails, another storage array controller module assumes control (claim 9). Sawdy's column 1 lines 1-10, column 2 lines 1-25.

Claim 3 rejected under 35 U.S.C. 103(a) as being unpatentable over Sawdy et al (US 6351831), Rauscher (US 6874100), Cruyningen (US Pub 2002/0019897) as applied to claim 2 and further in view of Brocade (Quick loop data sheet).

As in claim 3, Sawdy, Rauscher, Cruyningen do not expressly disclose the claim's aspect of the switch as a Fibre Channel quick loop switch. However, Brocade teaches of using the Fibre Channel Quick loop as an alternative to a hub-based solution (Brocade's column 1, lines 1-15). It would have been obvious to one of ordinary skill in the art at the time of invention to include a Fibre Channel Quick Loop as an alternative to a hub-based solution as suggested by Brocade, in Sawdy' system thereby further allowing the storage system to achieve superior performance and fault management (Brocade's column 1,lines 1-15).

Claims 5-7 rejected under 35 U.S.C. 103(a) as being unpatentable over Sawdy et al (US 6351831), Rauscher (US 6874100), Cruyningen (US Pub 2002/0019897) as applied to claim 1 and further in view of Deng (US 6937608).

As in claims 5-7, the claims recite wherein the first array controller units of the first and second storage array controller modules are grouped together into a first multicast group (claim 5); wherein a host broadcasts a command to the first multicast group (claim 6); wherein frames for the first array controller unit of the first storage array controller module are forwarded to the first array controller unit of the second storage array controller module (claim 7);

Sawdy describes each controller has tables to keep tracks of the mapping of devices in the storage system (such as device addresses, port name, I/O ports, Sawdy's column 3), Thus by using the maps, a controller can "forwarding" the requests from hosts to the proper device (Sawdy's column 2 lines 4-26; Cruyningen further describes the commands to disks are preferred managed as a "group" unit; Cruyningen's page 3 paragraph 42). Sawdy, Rauscher, Cruyningen do not expressly disclose the claim's aspect of a multicast group. However, Deng describes a method for a switch to forwarding a packet to only ports in the multicast group. It would have been obvious to one of ordinary skill in the art at the time of invention to include switch forwarding scheme as suggested by Deng in Sawdy's system to reduce network traffic thereby allowing the switch to be used for a multiple multicast streams (Deng's column 3 lines 1-10, lines 50-60).

Claims 10-12,14-18,20,22-27 rejected under 35 U.S.C. 103(a) as being unpatentable over Sawdy et al (US 6351831), Rauscher (US 6874100), Cruyningen (US Pub 2002/0019897) and further in view of Workman et al (US Pub 2004/0068591), Jantz (US 5944838).

As in claim 10, the claim recites a method for maintaining operation of a storage array network system, comprising: submitting a command to a primary array controller module and a secondary array controller module; performing a handshaking protocol between the primary array controller module and the second array controller module to determine which of the primary and the second array controller modules is to process the command; removing the command from a queue of the secondary array controller module; and timing of an aspect of the command. The claim rejected based on the same rationale as of claim 1. Sawdy, Rauscher, Cruyningen do not expressly describe the claim's detail of the handshaking protocol. However, Workman describes a handshake protocol on the heartbeat path between the first and second storage controllers to determine which of the first and second storage controllers to process the command (Workman's page 3 paragraphs 30-31; Fig 2). It would have been obvious to one of ordinary skill in the art at the time of invention to include the heartbeat signals as suggested by Workman in Sawdy's system to monitor and determine if a switch over is required (Workman's page 3 paragraph 30 lines 16-23).

Sawdy, Rauscher, Cruyningen, Workman do not expressly disclose the claim's aspect of a command queue. However, Jantz describes separate queues containing pending commands for each I/O paths A, B. In the situation of a failure on the first I/O path A, the command is executed and removed from the alternated queue of path B (Jantz's column 7 lines 5-35). It would have been obvious to one of ordinary skill in the art at the time of invention to include the command

queues as suggested by Jantz in Sawdy's system so that the I/O pending requests can be rapidly identified and restarting all such identified I/O requests on the alternate good I/O path. (Jantz's column 7 lines 28-35).

As in claims 11-12, the claims recite wherein the step of performing a handshaking protocol includes the substeps of, if the primary array controller module is able, sending a primary module ready signal to the secondary array controller module; if the secondary array controller module is able, sending a secondary module ready signal to the primary array controller module; and if the primary array controller module is able, processing the command before an expiration of a given time (claim 11); wherein the step of performing a handshaking protocol includes the substeps of if the primary array controller module is able, sending a primary module acknowledge signal to the secondary array controller module upon receipt of the secondary module ready signal (claim 12). The claim rejected based on the same rationale as of claim 10.

As in claim 14, the claim recites wherein the step of performing a handshaking protocol includes the substep of disabling ports associated with a drive tray bank associated with the primary array controller module. Sawdy column 2 lines 40 to column 6 lines 35 clearly describes a cable failure situation in which the surviving controller will assuming all devices of the failing controller; thus the ports that being assigned to the failure controller will be disabled.

As in claim 15, Sawdy does not describe the claim's detail of successfully handshaking. However, Workman describes wherein if the primary array controller module successfully handshakes with the secondary array controller module within a given time, the primary array controller module processes the command (Workman's Fig 2: #104 yes).

As in claims 16-17, the claims recite wherein if the secondary array controller module unsuccessfully handshakes with the secondary array controller module within a given time, the secondary array controller module processes the command (claim 16); wherein when the timing reaches a time limit, processing of the command is performed by the secondary array controller module (claim 17). Sawdy does not describe the claim's detail of unsuccessfully handshaking. However, Workman describes the second storage device takes over the operation when the heartbeat signal failures (Workman's page 3 paragraph 35).

As in claim 18, the claim recites wherein the time limit is measured from a time of transmission of the command from a host. Sawdy does not describe the claim's detail of time limit. However, Workman describes the algorithm is based on if commands from the host operate normally in the first storage node (Workman's page 3 paragraph 30 lines 1-7).

As in claim 20, Sawdy describes wherein redundancy and drive control is accomplished through multiple storage array controller modules (Sawdy's Fig 2). Claim 21 rejected based on the same rationale as of claim 9.

As in claim 22, the claim rejected based on the same rationale as of claims 10.

As in claims 23-24 the claim recites wherein both the primary and secondary array controller modules are in active mode (claim 23); wherein one of the primary and secondary array controller modules is in standby mode (claim 24). The rationale in the rejection of claim 22 is incorporated herein. Jantz further describes his multiple queues structures are operable in active controllers mode (Jantz's column 1 lines 45-55). Jantz's method of providing a separate queue or path B that contains identical commands as in the queue for path A would works equally well for dual controllers in standby mode.

Claim 25 rejected based on the same rationale as of claim 14.

Claim 26 rejected based on the same rationale as of claim 20.

Claim 27 rejected based on the same rationale as of claim 9.

Claims 19,21 rejected under 35 U.S.C. 103(a) as being unpatentable over Sawdy et al (US 6351831), Rauscher (US 6874100), Cruyningen (US Pub 2002/0019897), Workman et al (US Pub 2004/0068591), Jantz (US 5944838) as applied to claim 18, and further in view of Ito et al (US 2003/0014600).

As in claims 19, the claim recites wherein the command is transmitted from the host through an interface switch to the primary and secondary array controller modules. Sawdy, Rauscher, Cruyningen, Workman, Jantz do not expressly disclose the switch between host and storage controllers. However, Ito describes such a topology wherein multiples hosts are connecting to multiples storage controllers using switches (Ito's Fig 1, Fig 10). It would have been obvious to one of ordinary skill in the art at the time of invention to include the switches as suggested by Ito in Sawdy's system and thereby allowing host computers connect to devices using multiple paths.

Claim 21 rejected based on the same rationale as of claim 9.

(10) Response to Argument

Appellant's arguments in response to the last office action has been fully considered but they are not persuasive. Examiner respectfully traverses Appellant's arguments for the following reasons:

As to Appellant's remarks at pages 5-9 for the rejection of claims 1-2, 4, and 8-9

A) Appellant argues at page 6 lines 6-8 that Sawdy does not disclose the claim's limitation "a first and second storage array controller module wherein each storage array controller module has a first and second array controller unit and an array of storage device". Examiner disagrees. Sawdy discloses two controller modules (Sawdy's Fig 2: controller A and B modules). Each storage controller module comprises two storage controller units (Sawdy's Fig 2: storage controller units, port 0 and port 1); Sawdy further discloses an array of storage devices Fig 1: #214 that are accessed by controller modules A and B. Accessing of storage devices by storage control units is illustrated in Fig 2: Port 0, 1. Each of the Ports 0, 1 as shown in Fig 1 represents associating logic that provides appropriate paths to connect hosts to the arrays of storage disks (Fig 2: #218 disks and Fig 3: #210, #212 port 0,1) as further shown in Fig 3: #210, #212 ports 0, 1. Therefore Sawdy clearly teaches "A first and second storage array controller" as recited in the claim.

Sawdy further discloses the redundancy aspect of the claim by teaching that the controllers A, B operate in a redundant manner, and transmit from one controller to another (column 1 lines 25-30), for example, during a failover situation (Sawdy's column 2 line 67 to column 3 line 3).

B) Regarding Appellant's arguments at page 6 second paragraph to page 7 first paragraph, Appellant argues that "Rauscher fails to disclose a first storage array controller

module which provides an availability signal to the second storage array controller module..". It's noted Sawdy clearly discloses the redundant storage controller modules including the first storage array controller module and the second storage array controller module as discussed in above item A. The signal communication between two systems (i.e. the first storage array controller module and a second storage array) is taught by Rauscher as follows:

Rauscher further teaches a heartbeat signaling that allows two processing systems to communicate with each other vie heartbeat signaling such that if one controller fails to signal the other, the remaining processing system will initiates the fail over procedure (Rauscher's column 2 lines 56-68).

Appellant's argues that "Rauscher merely mentions a heartbeat signal with no time limitation". While it may be true that Rauscher does not expressly recite a time limitation for the heartbeat signal, this is no way precludes Rauscher from mentioning the limitation set forth in the claims, as discussed in the final rejection. One of ordinary skill in the art would know that a heartbeat signal is a signal for communicating between processes/systems in a periodic manner such that the time period is the period of the heartbeat signal, and that failure to communicate (send/response) means one of the process/system has failed. The authoritative dictionary of IEEE standard terms seventh edition December 2000 states " **heart beat** A signal or a message passed between cooperating processes to indicate continuing proper operations" (page 509 attached).

Based on the above definition of heartbeat signal, it is clear that the claim's recitation "wherein if the second storage array controller module does not receive a signal from the first storage array controller module within a given period of time, the second storage array controller module asserts control over the array of storage device", is nothing more than a description of

how the heartbeat signal normally operated. Rauscher's heartbeat signal clearly meets the claim limitations.

Regarding Appellant's arguments at page 7 second paragraph, Appellant argues that "Rauscher is concerned with double cabling to proof a RAID system again any point of failure, not utilization of a heartbeat signal". Examiner disagrees with Appellant's mischaracterization of double cabling. Rauscher teaches the importance of utilizing heartbeat signals in redundant systems, and further teaches that to enhance the reliability and availability of redundant systems, all components (cables carrying signals such as heartbeat signals, disks, controller etc.) must be duplicated to avoid a single point of failure (Rauscher's column 7 lines 38-48).

C) Regarding Appellant's arguments at page 7 third paragraph to page 9, Appellant argues that "Cruyningen does not disclose first and second array controller units within a storage control module". Examiner does not rely on Cruyningen for the teaching of "the first and second array control units" because this limitation is taught by Sawdy as discussed in above item A. However, Cruynigen discloses a method in which the storage array controller modules (Cruynigen's Fig 7: #20a, #20d storage array modules) work in conjunction with the storage array controller units (Cryuningen's Fig 7: storage channels 14ad1, 14ab2, 14cd2) to performing storage array control functions to arrays of storage devices (disks in storage array 20a, 20d), such as reconfiguring/grouping of disks in an array (Cryuningen discloses that array disks are readily reconfigured/grouped so that they can be accessed by both storage array controller modules or in separate groups of devices that only can be accessed by a particular storage control module). One skill in the art would be motivated to include Cryuningen's method into Sawdy's system so that

in case one controller failed, the surviving controller has access to all the storage devices seamlessly (Cryuningen's paragraph 38).

C1) On page 8, second paragraph, Appellant asserts, "there is no motivation to use the teachings of Sawdy, Rausher, and Cruyningen in combination. All three references relate to complete different areas of the storage system field, [a]ll three references solve totally different problems with totally different approaches. There is no motivation in Sawdy, Rauscher, and Cruyningen to combine the disparate disclosures to solve the problem addressed by the present invention."

This argument however is not persuasive. Examiner maintains that teachings all three of the cited references are in fact analogous art with respect to Appellant's invention. Pursuant to MPEP 2141.01(a), "[i]n order to rely on a reference as a basis for rejection of an applicant's invention, the reference must either be in the field of applicant's endeavor or, if not, then be reasonably pertinent to the particular problem with which the inventor was concerned." *In re* Oetiker, 977 F.2d 1443, 1446, 24 USPQ2d 1443, 1445 (Fed. Cir. 1992).

Appellant concedes that all three references relate to the storage system field. Examiner agrees with Appellant's concession, and further asserts that Applicant's invention is too, related to the storage system field (see paragraph 0001 of Appellant's specification – "[t]he present invention relates to the field of storage devices.". The prior art relied upon in these rejections are all directed to improving the efficiency of storage systems (more specifically, RAID system), as disclosed in col. 1, lines 5-30. col. 4, lines 21-46, and paragraphs 0005 and 0014, all lines, in Sawdy, Rauscher, and Cruyningen's disclosures, respectively. Examiner properly combined three analogous prior art references, and further provided explicit motivations from each of the

teaching references to properly establish why one of ordinary skill on the art would sufficiently motivated to combine the teachings (these motivations are found in the Office action made FINAL – page 3, line 17 through page 4, line 6). The rejections are therefore maintained since Examiner established a *prima facie* case of obviousness by properly asserting a motivation to combine these three prior art references.

D) Regarding Appellant's remarks at page 9 for the rejection of claim 3, the claim is rejected based on discussion in items A,B,C,C1.

E) Regarding Appellant's remarks at pages 9-10 for the rejection of claim 5-7, the claims are rejected based on discussion in items A,B,C,C1.

F) As to Appellant's remarks at pages 10-14 for the rejection of claims 10-12,14-18,20 and 22-27, Appellant argues that Workman "does not teach the handshake protocol at all..", and Workman does not teaches the claim's limitations "performing a handshaking protocol between the primary array controller module and the second array controller module .." . Examiner disagrees. The authoritative dictionary of IEEE standards terms seven edition December 2000 states " **handshake** ....(1) An interlocked exchange of signals between a master and a slave, controlling the transfer of data. (2) a hardware or software sequence of events requiring mutual consent of condition prior to change. (3) An interlocked sequence of signals between interconnected boards in which each board waits for an acknowledgement of its previous signal before procedding." (page 503 attached).

Workman's paragraph 31 lines 11-15 discloses the first storage controller/node sends a signal to the second storage controller/node (a token), the second storage controller does not respond, or incorrectly responds that causes the first storage controller/node to detect failures

occurring at the second controller/node. Thus Workman clearly teaches a handshake protocol between two processing elements in a consistent manner as the "handshake " being defined in above paragraph.

G) Regarding Appellant's arguments that Jantz does not teach a command queue. Examiner disagrees. Jantz discloses intelligent storage controllers (Fig 3: RDAC multiple storage controllers to provide redundancy, column 1 lines 48-55) each having its own queues for storing commands to disks (Fig 3: #306, #308, column 6 lines 58-67 queues in each storage controller for buffering I/O requests of each controller RDAC to disks), the queues are embedded in storage controller modules within the storage subsystem (Jantz's column 1 lines 40-45, queues implemented using memory elements in storage system), and thus constitute command queues.

G1) Appellant asserts on page, 12, third paragraph, "Examiner has combined no less than five references to meet each limitation of Claims 10 and 22 and has failed to provide any support for combining each of the five references."

This argument is not persuasive as Examiner fails to see how the number of references relied upon in a rejection bears any relevance on the patentability of the instant claim (see MPEP 2145, subsection V – "[r]eliance on a large number of references in a rejection does not, without more, weight against the obviousness of the claimed invention. *In re Gorman*, 933 F.2d 982, 18 USPQ2d 1885 (Fed. Cir. 1991)). Examiner maintains each and every 103(a) rejection set fort meet the four Graham v. John Deere Co. factual inquires set forth in MPEP 2141, hence Examiner has met burden of providing a *prima facie* case of obviousness. With respect to Appellant's assertion that Examiner failed to provide any support for combining each of the five references, Examiner maintains as per the arguments set forth in section C1 of the

correspondence, *supra*, that the cited references are analogous art, and explicit motivation to combine the references was cited to properly establish *a prima facie* case of obviousness.

Claims 22 is rejected based on the rational discussed in items F,G,G1.

Depending claims 11-12,14-18 and 20 are rejected based on the rational discussed in items F,G,G1.

H) Regarding Appellant's arguments at page 14 for the rejection of dependent claims 19, 21. The claims are rejected based on the rational discussed in items F,G,G1.

(11) Related Proceeding(s) Appendix

No decision rendered by a court or the Board is identified by the examiner in the Related Appeals and Interferences section of this examiner's answer.

For the above reasons, it is believed that the rejections should be sustained.

Respectfully submitted,

Duc Doan

Duc Doan
Examiner
Art Unit 2188

/CEW/

Conferees:

HYUNG S. SOUGH
SUPERVISOR

11/05/07

/Lynne H Browne/
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Attachment:
IEEE 100 The Authoritative Dictionary of IEEE Standards Terms 2000 (pages 503 and 509)

hand-feed punch A card punch into which cards are manually entered and removed one at a time. *Synonym:* hand punch. *Contrast:* automatic-feed punch. (C) 610.10-1994w

hand-held computer A portable computer small enough to be held and operated while holding it in one hand. (C) 610.10-1994w

handhole (1) An opening in an underground system containing cable, equipment, or both into which workmen reach but do not enter. (T&D) C2.2-1960

(2) An access opening, provided in equipment or in a below-the-surface enclosure in connection with underground lines, into which personnel reach but do not enter, for the purpose of installing, operating, or maintaining equipment or cable or both. (NESC) C2-1997

handler (1) A module or device that responds to a bus request (such as an interrupt request) as the slave to that request. (C/BA) 1014.1-1994w

(2) A program or routine that performs or controls one task (e.g., error detection). (SCC20) 1226-1998

handling device (of metal-clad switchgear) That accessory used for the removal, replacement, or transportation of the removable element. (SWG/PE) C37.100-1992

handling zone The portion of a disk or other storage medium that may be touched by the gripping mechanism or actuator. *Contrast:* recording area. (C) 610.10-1994w

hand/metal discharge *See:* hand/metal ESD.

hand/metal ESD An ESD from an intruding human hand that occurs from an intervening metal object such as a ring, tool, key, etc. *Synonym:* hand/metal discharge. (EMC/PE/SPD) C63.16-1993, C62.47-1992r

hand operation Actuation of an apparatus by hand without auxiliary power. *See also:* switch. (IA/ICTL/IAC) [60], [84]

hand-printed character font An international standard optical font for use on hand-generated documents. *See also:* OCR-B; OCR-A. (C) 610.2-1987

hand-print recognition Optical character recognition of hand-printed characters. (C) 610.2-1987

hand punch *See:* hand-feed punch.

hand receiver An earphone designed to be held to the ear by the hand. (EEC/PE) [119]

hand-reset relay A relay so constructed that it remains in the picked-up condition even after the input quantity is removed; specific manual action is required to reset the relay. *Synonym:* mechanically reset relay. (SWG/PE) C37.100-1992

handset (1) (transmission performance of telephone sets) An assembly that includes a handle and a telephone set transmitter and receiver. Other components such as the speech network may also be located in the handset. (COM/TA) 269-1983s

(2) An assembly intended to be held in the hand of the user that includes a transmitter and receiver. (For the purposes of this standard, a handset is a four-wire device, that is, it does not include a built-in speech network.) (COM/TA) 1206-1994

handset telephone *See:* hand telephone set.

handsfree reference point (HFRP) The calibration point on the reference axis of the mouth simulator, 50 cm in front of the lip plane. (COM/TA) 1329-1999

handsfree telephone (HFT) A device for connection to a telephone network capable of two-way voice communication without close coupling to the user's mouth or ear. (COM/TA) 1329-1999

handsfree telephone test circuit An assembly consisting of a handsfree telephone set(s) and interface(s) as may be required to realize simulated partial telephone connections. (COM/TA) 1329-1999

handshake (1) (FASTBUS acquisition and control) An interlocked exchange of signals between a master and a slave, controlling the transfer of data. (NID) 960-1993

(2) (test, measurement, and diagnostic equipment) A hardware or software sequence of events requiring mutual consent of conditions prior to change. (MIL) [2]

(3) (STEbus) An interlocked sequence of signals between interconnected boards in which each board waits for an acknowledgement of its previous signal before proceeding. (C/MM) 1000-1987r

handshake cycle (digital interface for programmable instrumentation) The process whereby digital signals effect the transfer of each data byte across the interface by means of an interlocked sequence of status and control signals. (An interlocked sequence is a fixed sequence of events in which one event in the sequence must occur before the next event may occur.) *See also:* interlocked sequence. (IM/AIN) 488.1-1987r

handshake status A status transfer which indicates the exchange of data between bus owner and replying agent(s). (C/MM) 1296-1987s

handshaking The exchange of predetermined signals or control measures between two systems or system components upon initial exchanges. *Note:* When the connection is established, the two components acknowledge each other. (C) 610.7-1995, 610.10-1994w

hand telephone set (telephone) A telephone set having a handset and a mounting that serves to support the handset when the latter is not in use. *Note:* The prefix desk, wall, drawer, etc., may be applied to the term hand telephone set to indicate the type of mounting. *See also:* telephone station. (PE/EEC) [119]

hand-to-metal impedance The impedance between the human hand and the metal object with which it is associated in a hand/metal ESD. The metal object is usually the intruder discharge electrode. Examples of hand-to-metal impedance include resistance and capacitance between the fingers and a key, between the wrist and a metal watch or bracelet, and between the hand and a screwdriver. (SPD/PE) C62.47-1992r

handwheel A wheel the rim of which serves as a handle for manual operation of a rotary device. (IA/ICTL/IAC) [60]

hand winding (rotating machinery) A winding placed in slots or around poles by a human operator. *See also:* rotor; stator. (PE) [9]

hang-off (accelerometer) (gyros) The displacement of an inertial sensing element from its null position that occurs when an input is applied and that is due to the finite compliance of a capture loop or a restoring spring. (AES/GYAC) 528-1994

hangover *See:* tailing.

hang-over time (T_H) Time from the input signal going below the threshold level until 3 dB of switched loss is inserted in the output signal. *Synonyms:* decay time; release time. (COM/TA) 1329-1999

hang-up hand telephone set (bracket-type handset telephone) (suspended-type handset telephone) A hand telephone set in which the mounting is arranged for attachment to a vertical surface and is provided with a switch bracket from which the handset is suspended. *See also:* telephone station. (PE/EEC) [119]

hang-up signal (telephone switching systems) A signal transmitted over a line or trunk to indicate that the calling party has released. (COM) 312-1977w

HA1 receiver weighting (data transmission) A noise weighting used in a noise measuring set to measure noise across the HA1 receiver of a of a subset with a number 302 receiver or a similar subset. The meter scale readings are in the dBa (HA1). (PE) 599-1985w

hard copy (1) (computer graphics) A printed copy of computer output in a readable form; for example, a printed report, a listing. *Contrast:* soft copy. (C) 610.2-1987, 610.6-1991w

(2) A paper record of information (e.g., reports, listings, logs, and charts). (SUB/PE) C37.1-1994

(3) A permanent record of information in readable form for human use, for example, reports, listings, displays, logs, and charts. (SWG/PE) C37.100-1992

act upon the command contained within the command field. (TT/C) 1149.5-1995

head gap (1) (test, measurement, and diagnostic equipment) The space or gap intentionally inserted into the magnetic circuit of the head in order to force or direct the recording flux into or from the recording medium. (MIL) [2]

(2) The distance between a read/write head and the surface of a recording medium. (C) 610.10-1994w

heading (navigation) The horizontal direction in which a vehicle is pointed, expressed as an angle between a reference line and the line extending in the direction the vehicle is pointed, usually measured clockwise from the reference line. *See also:* navigation. (AES/RS) 686-1982s, [42]

heading-effect error (navigation) A manifestation of polarization error causing an error in indicated bearing that is dependent upon the heading of a vehicle with respect to the direction of signal propagation. *Note:* Heading-effect error is a special case of attitude-effect error where the vehicle is in a straight level flight: it is sometimes referred to as course push (or pull). *See also:* navigation. (AES/RS) 686-1982s, [42]

headlamp (illuminating engineering) A major lighting device mounted on a vehicle and used to provide illumination ahead of it. *Synonym:* headlight. (EEC/IE) [126]

headlight *See:* headlamp.

head loading zone The relative distance that a read/write head travels with respect to a rotating storage device in order to achieve the proper clearance between the head and the surface of the medium. (C) 610.10-1994w

headloss (hydroelectric power plants) Loss of potential energy mainly due to hydraulic friction. This loss is usually expressed in feet or meters of head. (PE/EDPG) 1020-1988r

head of bus function The function that generates *empty Queued Arbitrated (QA) slots, Pre-Arbitrated (PA) slots,* and *management information octets* at the point on each bus where data flow starts. The Head of Bus function also inserts the *virtual channel identifier* in the *PA segment header* of PA slots. (LM/C) 8802-6-1994

head or butt cable *See:* hand (head or butt) cable (mining).

head-per-track disk drive A disk drive in which one fixed head is located over each track on the drive. (C) 610.10-1994w

head positioner A component within a storage device that positions a floating head over a specific track on the storage medium. (C) 610.10-1994w

headquarters system (direct-connected system) A local system to which has been added means of transmitting system signals to and receiving them at an agency maintained by the local government, for example, in a police precinct house, or fire station. *See also:* protective signaling. (PE/EEC) [119]

head receiver An earphone designed to be held to the ear by a headband. *Note:* One or a pair (one for each ear) of head receivers with associated headband and connecting cord is known as a headset. (EEC/PE) [119]

headset An assembly, including a transmitter and receiver, intended to be worn on the head of the user. (COM/TA) 1206-1994

head space (test, measurement, and diagnostic equipment) The space between the reading or recording head and the recording medium, such as tape, drum or disc. (MIL) [2]

head switching (A) The use of two read/write heads, one to read from the medium and one to write on another medium. **(B)** The process of switching from one head to another, either on the same or on different storage media. (C) 610.10-1994

headwater (hydroelectric power plants) Source of energy for a hydraulic turbine. (PE/EDPG) 1020-1988r

head water benefits (power operations) The benefits brought about by the storage or release of water by a reservoir project upstream. Application of the term is usually in reference to benefits to a downstream hydroelectric power plant. (PE/PSE) 858-1987s

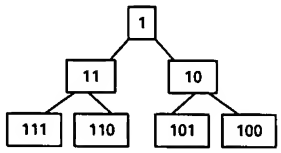
headway The time interval between the passing of the front ends of successive vehicles or trains moving along the same lane or track in the same direction. (VT/RT) 1474.1-1999

health Summary information regarding the current ability of a system or subsystem to perform its intended function. (VT) 1482.1-1999

health care facilities (health care facilities) Buildings, portions of buildings, and mobile facilities, that contain but are not necessarily limited solely to premises designed for use as hospitals, nursing homes, residential custodial care facilities, clinics, or medical and dental offices. (NESC/NEC) [86]

health information system (HIS) *See:* hospital information system.

heap (data management) A complete binary tree in which the key for each child node contains the key from its parent plus some additional value.



heap

(C) 610.5-1990w

heapsort A tree selection sort in which the items to be sorted are used to build a heap, and the items are then selected from the heap in the sorted order. (C) 610.5-1990w

hearing loss (1) (for speech) The difference in decibels between the speech levels at which the average normal ear and the defective ear, respectively, reach the same intelligibility, often arbitrarily set at 50 %.

(2) (hearing-threshold level) (ear at a specified frequency) The amount, in decibels, by which the threshold of audibility for that ear exceeds a standard audiometric threshold. *Notes:* 1. *See:*American Standard Specification for Audiometers for General Diagnostic Purposes. 2. This concept was at one time called deafness: such usage is now deprecated. 3. Hearing loss and deafness are both legitimate qualitative terms for the medical condition of a moderate or severe impairment of hearing, respectively. Hearing level, however, should only be used to designate a quantitative measure of the deviation of the hearing threshold from a prescribed standard. (SP) [32]

heartbeat A signal or a message passed between cooperating processes to indicate continuing proper operations. *See also:* signal quality error heartbeat. (C) 610.7-1995

heat capacity (1) The amount of heat necessary to raise the temperature of a given mass of a substance 1°—the mass multiplied by the specific heat. (IA/PSE) 241-1990r

(2) *(A) homogeneous conductors:* The specific heat of the conductor's material times the mass per unit length. *(B) nonhomogeneous conductors:* The sum of the heat capacities of the conductor's component materials. (T&D/PE) 738-1993

(3) The heat required to raise the temperature of a unit mass of material by one degree. (DEI) 1221-1993w

heat detector (1) (burglar-alarm system) A temperature-sensitive device mounted on the inside surface of a vault to initiate an alarm in the event of an attack by heat or burning. *See also:* protective signaling. (PE/EEC) [119]

(2) (fire alarm system) A device that detects abnormally high temperature or rate-of-temperature rise to initiate a fire alarm. (NFPA) [16]

heater (1) (electric pipe heating systems) A length of resistance material connected between terminals and used to generate heat electrically. Heaters, as used in this application, can take the form of cables with various sheath materials, blankets, and pads. *Synonym:* heating element. (PE/EDPG) 622-1979s

(2) (electron tube) An electric heating element for supplying heat to an indirectly heated cathode. *See also:* electrode. (ED) 161-1971w